MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

TAI2151 – ARTIFICIAL INTELLIGENCE FUNDAMENTALS

(All Sections/Groups)

6 October 2015
2.30pm – 4.30pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **5** pages with **6** questions only.
2. Attempt **FIVE** out of **SIX** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

Question 1

(a) State the Turing Test. (2 marks)

(b) Define rational agent and compare reflex agent with goal-based agent. (5 marks)

(c) An agent receives percepts from the environment through sensors and acts upon the environment through actuators.

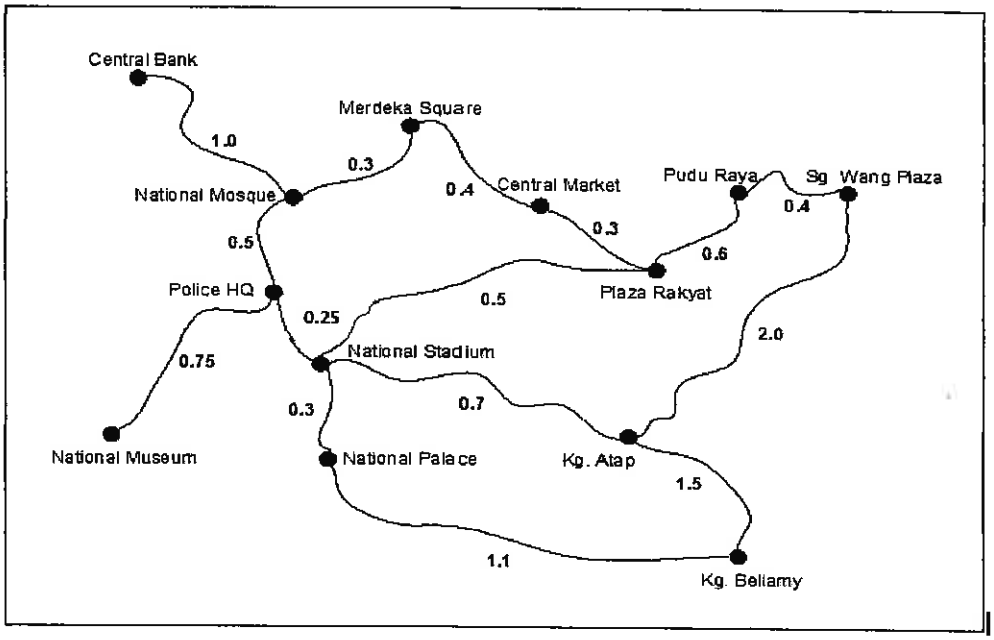
What are the percepts and actions of the following agents? List at least one percept and one action for each agent.

(i) Thermal sensor alarm to detect intruders used in security devices
(ii) Television
(iii)Can-drink vending machine (machine that sells soft drink cans) (3 marks)

Continued....

Question 2

(a) *The following is a map of a part of Kuala Lumpur with distances between areas shown in* kilometres. Draw the search tree for the map with the areas as nodes. The search tree starts at Central Bank and ends at Kg. Bellamy. Do not include repeated nodes.
Note: The map is not drawn to scale and the distances shown are for the purpose of the question only. (4 marks)



(b) Using the Kuala Lumpur map and search tree from part (a) above, obtain the path and path cost from Central Bank to Kg. Bellamy using
(i) Greedy search
(ii) A* search
Use the straight line distance (SLD) from Kg. Bellamy below as a heuristic function. (4 marks)

Area	**SLD from Kg. Bellamy (in km)**
Central Bank	2.8
National Mosque	2.2
Police HQ	1.3
National Museum	2.0
Merdeka Square	2.1
Central Market	2.0
Pudu Raya	2.6
Sg. Wang Plaza	2.5
Plaza Rakyat	1.9
National Stadium	1.1
National Palace	0.9
Kg. Atap	0.7
Kg. Bellamy	0

(c) Why is the SLD as shown above an admissible heuristic? (2 marks)

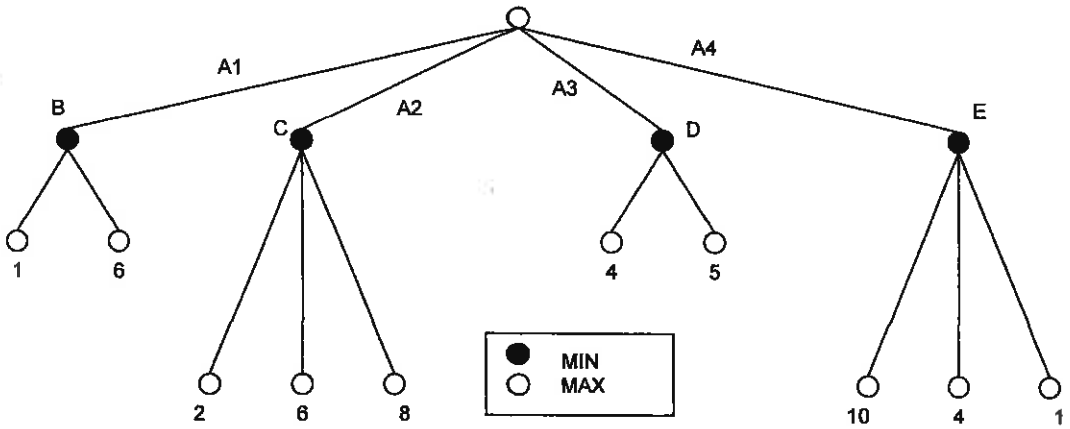
Continued....

Question 3

(a) Four criteria were defined for comparing search strategies: completeness, optimality, time complexity, and space complexity. Specify the question, related to the search algorithm's performance, which is addressed by each of these four criteria. (2 marks)

(b) Which one of these four criteria in (a) the reason of the followings?
(i) Iterative-Deepening search is usually preferred over Breadth-First search.
(ii) Bidirectional search is usually preferred over Iterative-Deepening search.
(iii)A* search is usually preferred over Best-First Search.
(iv)Breadth-First search is usually preferred over Depth-First search? (2 marks)

(c) Minimax algorithm is used as a search tool in two-player games. The figure below shows a minimax search tree for a simple game, where the terminal utility (static evaluator) values are as shown.



i. What are the utility values for nodes B, C, D and E? (2 marks)
ii. What is the final minimax decision? (1 mark)

(d) Assume that the minimax algorithm is modified to make the game's objective to maximise the utility values.

i. What are the new utility values for nodes B, C, D and E? (2 marks)
ii. What is the new final minimax decision? (1 mark)

Continued....

Question 4

(a) Show by means of a truth-table that $\neg(P \wedge Q) \Leftrightarrow (\neg P \vee \neg Q)$. (3 marks)

(b) Look at the following sentence and decide, if it is valid, unsatisfiable, or satisfiable. Verify your decision using equivalence rules:

$(Smoke \Rightarrow Fire) \Rightarrow ((Smoke \wedge Heat) \Rightarrow Fire)$ (3 marks)

(c) Let $P(x)$ and $Q(x)$ be predicates. The following is a tautology in predicate logic.

$$\exists x\ (P(x) \Rightarrow Q(x)) \Leftrightarrow (\forall x\ P(x)) \Rightarrow (\exists\ x\ Q(x))$$

Complete the derivation of this equivalence below using step-by-step substitutions, based on general equivalence laws that you have learned. You only need to write appropriate predicates for the blank spaces (I), (II), (III), and (IV).

				General Rule Used:
1.	$\exists x\ (P(x) \Rightarrow Q(x))$	$\Leftrightarrow$	$\exists x\ (\neg P(x) \vee Q(x))$	[$p \Rightarrow q \Leftrightarrow \neg p \vee q$]
2.		$\Leftrightarrow$	$\neg\forall x\ \neg(\neg P(x) \vee Q(x))$	[$\exists x: p \Leftrightarrow \neg\forall x: \neg p$]
3.		$\Leftrightarrow$	$\neg\forall x\ (P(x) \wedge \neg Q(x))$	[One of DeMorgan's laws.]
4.		$\Leftrightarrow$	**(I)**	[$\forall x: (p \wedge q) \Leftrightarrow (\forall x: p) \wedge (\forall x: q)$]
5.		$\Leftrightarrow$	**(II)**	[One of DeMorgan's laws.]
6.		$\Leftrightarrow$	**(III)**	[$\neg\forall x: \neg q \Leftrightarrow \exists x: q$]
7.		$\Leftrightarrow$	**(IV)**	[$\neg p \vee q \Leftrightarrow p \Rightarrow q$]

(4 marks)

Question 5

(a) Translate the sentence "Birds fly except penguins." into first-order logic statements, assuming the following predicates have been defined:

Bird(x) = *x* is a bird
Penguin(x) = *x* is a penguin
Fly(x) = *x* flies (2 marks)

(b) From "Horses are animals," it follows that "The head of a horse is the head of an animal." demonstrate that this inference is valid by carrying out the following steps:

(i) Translate the premise and the conclusion into the language of first-order logic. Use three predicates: *HeadOf(h,x)*, *Horse(x)*, and *Animal(x)*. (2 marks)

(ii) Negate the conclusion, and convert the premise and the negated conclusion into conjunctive normal form. (3 marks)

(iii) Use resolution to show that the conclusion follows from the premise. (3 marks)

Continued....

Question 6

We would like to learn a decision tree for deciding whether or not you will like a given restaurant. Assume we have chosen two types: Price and Type, where Price has three possible values: Low (L), Medium (M), and High (H); and Type has two possible values: Hamburger (H) and Vegetarian (V). Consider the following training set consisting of five examples:

Example	*Attributes*		*Class*
	Price	**Type**	
1	L	H	+
2	L	V	+
3	M	H	-
4	M	V	+
5	H	V	-

For your information, $log_2 1 = 0$, $log_2 2 = 1$, $log_2 3 = 1.6$, $log_2 4 = 2$, $log_2 5 = 2.3$
Also, $log(x/y) = log\ x - log\ y$

(a) Using the Max Gain method, what is the best attribute for the root node of the decision tree? Show all your work. (8 marks)

(b) Construct the entire decision tree. (2 marks)

End of Paper